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Introduction

America is in the midst of an drug epidemic with over 100,000 drug-related deaths occurring in 2020 alone (CDC, 2021). Opioids – including prescribed painkillers, heroin, and synthetic opioids like fentanyl – are implicated in 75–80% of these deaths. An increase in deaths from other drugs (like cocaine, methamphetamine, and benzodiazepine) is also being driven by their use in combination with synthetic opioids like fentanyl (https://nida.nih.gov/research-topics/trends-statistics /overdose-death-rates accessed July 5th, 2022).

A debate has emerged over the cause of this epidemic which dovetails with previous debates on the causes of addiction and the war on drugs. Competing sets of arguments cluster by "elective affinity" (Weber [date]), and, as sets, implicitly or explicitly pass judgment on societal approaches to drugs and addiction and even to capitalism. On one side, there is a social democratic position for which rising opioid deaths, along with rising deaths from alcohol and suicide, constitute "deaths of despair" (Case and Deaton 2015, 2020). The ultimate upstream determinant of these deaths, from this perspective, is the loss of high-paying and stable jobs, especially for men in the manufacturing sector, and the consequences of job loss for individuals, families and communities over the long term. From this perspective, ultimate blame lies with deregulated and financialized contemporary capitalism, which facilitated the export of manufacturing jobs, the erosion of job stability, and prevented the development of an adequate health system and social safety net. This position fits with an understanding of addiction as a by-product of psychosocial stress and loss of meaning; people take drugs in order to palliate self-medicate from traumatic experiences; this drug use can becomes a destructive habit as, and the user loses control of their use and continues to use despite negative repercussions (a [the DSM?] definition of addiction). This last stage is accompanied by changes in the brain (although this is not the same thing as saying the drugs directly cause the change in the brain; [see Lewis 2018]). The solution to this epidemic would need to include policies that affect the "demand side" for drugs. There are different potential control points on the demand side.; Ddrug-resistance education to discourage use among those so inclined has a poor track record (DARE study here). However, iInterventions located further upstream in drug demand, such as social democratic welfare policies, could reduce or buffer the anomie and psychosocial stress emanating from the organization of the economy, and reorganization of the economy on democratic socialist principles could reduce the generation of stress.

The competing position emphasizes the drug environment, most importantly the availability of substances and how dangerous they are. This perspective implicitly assigns demand for drug use to ignorance, personal taste, or rational assessment of the tradeoff between the benefits of intoxication and its negative consequences, with no distinguishable role for economic structure conthedrives mortality from drug use. The opioid epidemic in the US started with the aggressive, unethical and perhaps illegal marketing of opioid pain medication by a handful of businesses, most prominently the marketing of Oxycontin by Purdue Pharma in 1996. Supposedly intended for slow release long-lasting, the initial formulation of this this medication could be crushed to produce an intense high similar to heroin. While there were other businesses involved, including other opioid makers, Johnson & Johnson as the supplier

of raw opium, as well as the large pharmaceutical distribution companies, the emphasis in this account is on unusual and unethical behavior. This "bad apple" theory of corporate misdeeds (Bakan 2004) attributes the harms caused by corporations to exceptional and immoral activity of particular corporate officers or owners (the immigrant Jewish Sackler family as owners of Purdue has drawn a lot of attention [Keefe Empire of Pain, 2021]). Such negative outcomes do not automatically result from the structure of corporations or the normal functioning of the economic system.

The supply interpretation locates the motive force of the opioid epidemic with the marketing of pain medications. Addiction to prescribed pain medication often converted to use of illegal opioids because they were cheaper or because it became easier to obtain illegal opioids than licit pills as medical institutions and governments tightened up the availability of these drugs. Pharmaceutical companies also made changes to make their products harder to abuse, potentially driving habitual users to alternatives.

In supply-push analysis, the key to the opioid epidemic rests not with demand for drugs caused by economic dislocation but with the evolving "drug environment": or "supply" of drugs rather than the "demand" for drugs caused by economic dislocation – first the supply of prescription opioids;, then of heroin;, and then of illicit synthetic opioids like fentanyl. This theory has an "elective affinity" with a chemical-based theory of drug addiction. According to this perspective, drug addiction occurs as a result of changes in the brain stemming from exposure to the chemical. For example, according to this theory, most people, if exposed to a sufficient amount of an addictive drug like cocaine or heroin, will become addicted to these drugs. (Alexander 2001). If it is the exposure to drugs that causes drug addiction, then logically it is the "drug environment" that determines deaths from drug use disorders. The two key features of the environment are availability and lethality. Some drugs will be particularly dangerous because they are prone to overdose (especially emphasized in the case of fentanyl). Another part of the drug environment are harm reduction strategies that treat addiction and reduce overdoses deaths. If drug availability and lethality are the most important causes of the opioid epidemic, then keeping the chemicals away from those they might harm becomes the core public health policy response, militating toward via prohibition and "war on drugs.") the most important public health policy will be prohibition and the war on drugs – keeping the chemicals away from those they might harm.

Both "supply" and "demand" explanations theories of the opioid crisis could be true; pharmaceutical companies have unethically and even illegally promoted pain medication, leading to addiction, substitution with illicit opiates, and deaths from drug use. At the same time, economic dislocation stemming from deindustrialization and the loss of stable and decent jobs could have been a large reason that people abused opiates.

A growing literature uses indicators like unemployment rates and declining household income as measures of "demand" and things like opioid prescribing rates as a measure of drug "supply." This includes studies that find a central role for demand (Nosrati et al 2019; Monnat 2019) and those that find supply the most important (Currie et al., 2018; Masters et al, 2017; Masters et al., 2018, Ruhm 2019). Many of the papers that highlight supply begin with with 2010 prescribing rates in the 2000s or 2010s as the starting point and document the subsequent harms in the 2010s and now 2020s associated with greater opioid supply at the dawn of the centuryin 2010. Ruhm (2019), for instance, regresses opioid analgesic death rates per 100,000 population on grams of the presecription of morphine milligram equivalents between 2000 and 2015. It is worth noting that even some authors who emphasize the supply effect find a

contemporaneous effect of economic disadvantage (e.g. Ruhm 2017 who finds a correlation between drug mortality and unemployment rates).

The supply-explanation studies have a major shared flaw: the supply of drugs (often proxied with prescription rates in a base year) is not necessarily exogenous. Economic decline generated both demand and supply, limiting the explanatory value of the distinction. There is evidence that pharmaceutical companies first targeted their aggressive marketing at locations where there was high despair-based demand, for example, in mining-dependent counties in Appalachia (Keyes et al., 2014; Quinones, 2015). Pharmaceutical companies targeted high-prescribing physicians with a fine-grained and aggressive marketing strategy to prescribe still more drugs (cite). Local or regional conventions of practice concerning prescriptions and state regulations concerning opioids affected where pharmaceuticals were marketed, but the demand for trauma relief provided by opioids played a central role in driving prescription patterns. We address this empirically in this paper. Specifically, we test whether prior economic decline is a predictor of future prescription rates. To operationalize economic decline, we focus on 1980–1989, a period of significant economic decline in the many US industrial regions, and well before Purdue began its nationwide aggressive marketing campaign of OxyContin in 1996. The outcome variable is the county-level opioid prescribing rates a full two decades later, in 2010.

Sustained economic decline over a 10-year period generates substantial psychosocial stress for the population. Yet population movement and other trends and events may obscure the population-health relationship between economic decline and the prevalence and consequences of opioid use. For economic decline to show measurable effects a full twenty years later at the county level is a demanding test of the deaths-of-despair hypothesis.

What are the possible mechanisms linking economic decline to higher prescription rates 20 years later? Perhaps the most obvious link could be that economic decline produced negative labor market outcomes that led to the breakup of families or otherwise traumatic experiences for children. Childhood trauma is a powerful predictor of future drug use. Particularly powerful evidence for this position comes from the Adverse Childhood Experiences (ACE) project. According to the Substance Abuse and Mental Health Services Administration: "Adverse childhood experiences (ACEs) are stressful or traumatic events, including abuse and neglect. They may also include household dysfunction, such as witnessing domestic violence or growing up with family members who have substance use disorders. ACEs are strongly related to the development and prevalence of a wide range of health problems throughout a person's lifespan, including those associated with substance misuse" (SAMHSA 2018). There is a huge effect of reported ACEs on illicit and prescription opioid abuse (Dube et al. 2003; Foster et al. 2017).

Other mechanisms could link medium-term economic decline with future opioid prescriptions. For example, there could be a lock-in effect of economic decline, as this decline could be driven by business or plant closings, leading to unemployment, reduced consumer demand and lower taxes in an area, leading to an eroding institutional environment, less overall investment overall, and less investment in health-promoting institutions. Such an inhospitable economic and government environment could easily increase drug use.

We do not attempt to identify the mechanism or mechanisms, only to test if there is a relationship between past economic decline and future opioid prescriptions.

Methods

We tested our hypothesis via multiple linear regression using a county-level panel dataset. The outcome is the (natural log) county-level opioid dispensing rate in 2010 (number of opioid prescriptions per 100 persons per year) provided by IQVIA Xponent, a private research database that estimates dispensing rates from a sample of approximately 49,900 retail non-hospital pharmacies (Centers for Disease Control and Prevention 2021).[1]

The 10-year change in median household income at the county level is the indicator of changing economic well-being. The 1980 and 1990 US decennial censuses include data on median household income from all sources at the county level in the preceding year (1979 and 1989). We adjusted the median household income in 1979 to 1989 US dollars using inflation factors from the U.S. Bureau of Labor Statistics Consumer Price Index (CPI–U–RS) and computed the change in real median household income from 1979–1989 for each county.

Regression models include a set of baseline covariates from the 1980 decennial census: whites as percent of the population; percent with bachelor's degree or higher; percent in urban classified area; percent over age 65; percent under age 18; percent in labor force (for those over age 16); percent of people with income below poverty level, and the natural log of the total population size. All decennial census data were gathered from the standardized datasets available through IPUMS NHGIS (Manson et al. 2021). We also included state fixed-effects in all models in order to account for additional state-specific confounders not captured by the other covariates.

We applied listwise deletion to form an analysis dataset with no missing values. We began with 3,143 counties from the 1980 census, which were joined by county FIPS code with opioid dispensing rates in 2010. 405 counties without dispensing rate data were dropped (these counties had a mean 1980 census population of 5,994). Counties may be missing dispensing rate data due to county boundary changes between 1980–2010 (for example, if two counties merged) or because "the county had no retail pharmacies and/or prescribers, the county had no retail pharmacies and/or prescribers sampled, or the prescription volume was erroneously attributed to an adjacent, more populous county according to the sampling rules used." (Centers for Disease Control and Prevention 2021). Due to the natural log transform of the outcome, we removed an additional 3 counties with reported 2010 dispensing rates of zero. The resulting analysis dataset consists of 2,733 counties.

We estimate

$$y_{is}=\beta X_{is}+a_s+\varepsilon_{is}$$

where i indexes county and s indexes state; y_{is} is the opioid dispensing rate (prescriptions per 100 persons) in 2010; X_{is} includes the key exposure variable, the change in county median household income between the 1980 and 1990 Censuses, as well as 1980 county-level covariates; a_s is a state fixed effect; ε_{is} is an error term.. We also report results from an alternative specification without state fixed effects. Regression coefficients are the change in

[1] There are other supply factors, most importantly illicit drugs like fentanyl, that we can not measure. It is of course very difficult to find a valid and reliable measure of illicit drugs, and none exists for fentanyl to our knowledge. However, most supply-side advocates usually argue that the pharmaceutical companies created the problem by flooding the market with prescription opioids, and once people were hooked they then took to street drugs like heroin or fentanyl. (Muhuri et al 2013).

the natural log of (approximately the percent change in) the opioid dispensing rate in 2010 corresponding to a unit increase in the predictor.

As a secondary analysis, we fit the same model with the sample limited to counties in Appalachia (423 counties in 13 states according to the definition used by the Appalachian Regional Commission).

Results

Table 1 summarizes the covariates, exposure, and outcome variables, and a correlation table of all variables is provided as Table A. The mean 1979–1989 change in county real median household income was $430 with a standard deviation among counties of $3,100. In 2010 the mean opioid dispensing rate was 93 prescriptions per 100 persons with a standard deviation of 49 prescriptions per 100 persons. The full distribution of changes in median household income and of the opioid dispensing rate are shown in Figure 1.

We then present the results from the main regression analysis. We find a statistically significant negative relationship between changes in median household income in the 1980s and opioid dispensing rates some 25 years later. In our preferred specification, with state fixed effects, a $1,000 change in county real median household income from 1979–1989 is associated with a 3.3 percent lower opioid dispensing rate in 2010 (=–0.033, 95% CI: –0.043, –0.024, p <0.001). (We report percent, *not* percentage point, although with a national mean of almost 100 prescriptions per 100 population, the percent and percentage point changes are similar.)

Among the county-level covariates, all measured in 1980, percent white and percent urban had significant positive associations with 2010 dispensing rates. Percent under 18 and labor force participation, both in 1980, had significant negative associations with 2010 dispensing rates. In the alternative specification without fixed effects, a $1,000 increase in real median household income from 1979–1989 is associated with a statistically significant 0.9% lower opioid dispensing rate in 2010 (=–0.0086, 95% CI: –0.017, –0.0006, p=0.035). In addition to the covariates that were significantly associated with the outcome in the preferred specification, in the alternative model percent over 65 in 1980 and percent with income below poverty level had significant associations with log opioid dispensing rates in 2010.

Results were very similar if less precisely estimated in the Appalachia subsample. In the preferred specification, a $1000 increase in county real median household income from 1979–1989 was associated with approximately 3% lower opioid dispensing rates in 2010 (=–0.032, 95% CI: –0.059, –0.004, p=0.023) in Appalachia. In the alternative specification without state fixed effects, the estimated association was –0.018 (95% CI: –0.044, 0.007, p=0.16).

To contextualize the results we present the main associations scaled to a one standard deviation increase in the main dependent variable, the change in median household income from 1979–1989 (mean: $430, standard deviation: $3,100). The preferred specification finds a one standard deviation change in the dependent variable is associated with –10% lower opioid dispensing rates (–2.6% in the alternative specification). This can be further contextualized by noting that the mean opioid dispensing rate in 2010 was 93 prescriptions per 100 persons. For the Appalachia subsample, a one standard deviation change in the dependent variable (mean: –$210, standard deviation: $285) was associated with –8.7% lower opioid dispensing rates (–4.8% in the alternative specification), and the mean opioid dispensing rate was 120 prescriptions per 100 persons.

Discussion

This paper provides strong evidence that opioid prescription rates cannot be considered purely a measure of "supply" or the "drug environment" as distinct from "demand" created by economic hardship. Change in household income from 1979–1989 is a large and statistically significant predictor of opioid prescription rates twenty years later. If medium term economic performance is associated with opioid prescription rates twenty years in the future, it seems very likely that more recent economic events, to the extent that they create psychosocial stress, will lead to a worsening of the opioid crisis and deaths of despair more generally. The 9% change in dispensing rates associated with a one standard deviation change is likely a very conservative estimate, as measuring economic decline 20 years in the past is a very hard test of the hypothesis. The real effect of economic decline is almost certainly much larger. Indeed, there exists a substantial amount of very high-quality data with excellent research designs demonstrating this link (King, Gabor and Nosrati 2022).

The stronger estimated effect in the model with state fixed effects may come as a surprise because reduced variation in fixed-effect models can attenuate the signal. The stronger result in the state fixed-effect model has several implications for our findings. First, the importance of the fixed effect indicates substantial heterogeneity between states in the economic parameters that constitute a troubled or declining county relative to other areas within the state. Focusing on within-state variation, as the state fixed effect model does, identifies problem areas, i.e., areas with reduced income growth, in relation to the regions in which they are embedded. Second, both the stronger fixed-effects results coupled with the stability of the result in the stratified Appalachia and non-Appalachia subsamples suggest that "left-behind areas" everywhere are at greater risk of receiving the opioid supply push. The relationship between economic decline and subsequent opioid supply is not being identified by historical happenstance, for example, of something that is specific to Appalachia. It is indeed left-behind counties everywhere—in each state, comparatively among the counties of Appalachia, and comparatively among the counties of non-Appalachia—that received the devastating supply onslaught of opioids in the first decade of the 2000s. To summarize, the stronger results in the fixed-model really suggest that it is left-behind places (counties) that get the supply push—rather than a peculiar happenstance that located the opioid push in Appalachia.

Economic decline in 1980–89 and prescribing rates in 2010 could both be endogenous to some longer-term process. Examples might include post-industrial transformation or even, to entertain a Conservative hypothesis, the long arc of secularization eroding morality and work ethic and simultaneously producing both an economic decline and opioid epidemic. (See the discussion of "supply side metaphysics" in Bluestone and Harrison [1982: 12–13] or the moral-economic perspective of Vance [2016]). In any case, the process is endogenous, and early 21st century opioid prescriptions or other supply indicators are not a suitable measure of a pure "supply" variable. We subscribe to a sequential and historically specific path of deindustrialization rooted in the strategies pursued by corporations to address declining profitability in the late 1960s to early 1970s.

Our focus on the demand-side explanation does not negate the relevance of the agency of Purdue Pharma. The unethical and illegal activity of not only Purdue but a number of truly giant corporations including (but not limited to) America's two leading pharmacies CVS and Walgreens, three leading drug wholesalers, and corporate icons Johnson & Johnson (who supplied the raw opium) and McKinsey (who advised many of these companies how to pursue opioid-related sales and to avoid oversight and regulation). Regulations on prescriptions and

other policies related to reducing harm and drug lethality are also undoubtedly causally important in deaths from drug use disorders.

As with addiction for the individual person, both "supply" and "demand" factors operate in population drug use. Corporations have increased both supply and demand: a narrow set of corporations bear responsibility for the supply factors; and a much broader set of corporations have augmented demand. Corporations, starting with the manufacturing sector and extending into services, globalized and downsized, even as their remaining employees became more exploited and precarious (Bluestone and Harrison 1982; Lazonick 2015), driving psychosocial factors contributing to the opioid epidemic in the short, medium and long-term.

Amongst the richest industrial countries the US is the leader in opioid deaths by a very wide margin. Supply efforts may close the gap: much as the tobacco companies turned to foreign markets to make up for declining sales in the US, Purdue Pharma did the same, launching a major campaign in Canada, driving opioid prescriptions in that country (Ryan et al., 2016)—an instance of "supply" precedence. But with the most insecure and deregulated economy amongst the rich countries (Avendono and Kawachi 2014) the US is also peculiarly vulnerable to trauma capitalism generating demand for opioids. The U.S. institutional legacy increasingly lacks any countervailing power to corporations, which were able to roll back unions and the welfare state from the 1980s onwards. Acting through both supply and demand, corporate power is the fundamental cause of the opioid epidemic.

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Table 1: Descriptive Statistics

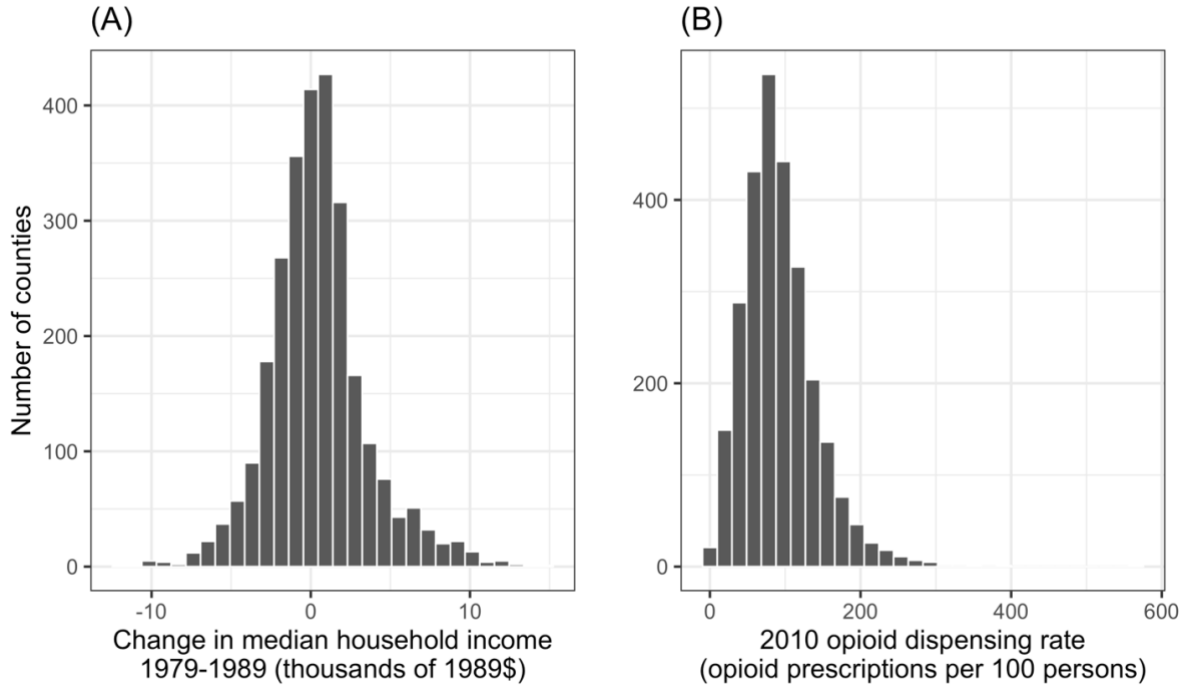
Variable	**Mean**	**Std. Dev**	**Min**	**Max**
Total population	82,000	250,000	1,700	7,500,000
% White	89	15	15	100
% Urban	40	29	0	100
% Under 18	29	3.5	16	47
% Over 65	13	3.9	1.4	34
% with Bachelors or higher	7.3	3.5	1.9	34
% In labor force (age 16 and over)	43	4.9	25	72
% Income below poverty level	15	6.8	3	50
Change in median household income 1979–1989 (thousands of 1989$)	0.43	3.1	–12	15
Opioid dispensing rate in 2010 (prescriptions per 100 persons)	93	49	0.6	570

Table 2: Multiple Regression Results

	National		**Appalachia**	
Predictor	**With State Fixed-Effects**	**Without State Fixed-Effects**	**With State Fixed-Effects**	**Without State Fixed-Effects**
Log total population	–0.003 (0.015)	0.0015 (0.014)	0.19*** (0.049)	0.088 (0.049)
% White	0.012*** (0.001)	0.0058*** (0.001)	0.01** (0.004)	0.007* (0.003)
% Urban	0.0084*** (0.001)	0.0073*** (0.001)	0.0051* (0.002)	0.0089*** (0.002)
% Under 18	–0.025*** (0.006)	–0.062*** (0.005)	–0.0047 (0.018)	–0.031 (0.018)
% Over 65	–0.0051 (0.005)	–0.054*** (0.004)	0.014 (0.017)	–0.045** (0.016)
% with Bachelors or higher	–0.018*** (0.005)	–0.053*** (0.005)	–0.015 (0.019)	–0.063*** (0.018)
% In labor force (age 16 and over)	–0.015*** (0.004)	–0.022*** (0.004)	–0.019 (0.011)	0.0076 (0.010)
% Income below poverty level	0.0019 (0.003)	0.011*** (0.003)	0.007 (0.008)	0.035*** (0.006)
Change in median household income 1979–1989 (thousands of dollars)	–0.033*** (0.005)	–0.0086* (0.004)	–0.032* (0.014)	–0.018 (0.013)
Adjusted R2	*31%*	*16%*	*31%*	*19%*

The outcome is the natural log of dispensing rates in 2010 (opioid prescriptions per 100 persons.) The model includes state fixed-effects (not displayed.) Standard errors are shown in parentheses; *P<0.05, **P<0.01, ***P<0.001.

Figure 1: Distribution of exposure and outcome variables



Histograms of (A) exposure variable (change in median household income from 1979–1989, measured in 1989$) and (B) outcome variable (2010 opioid dispensing rate, opioid prescriptions per 100 persons.)

Table A: Correlation Table

	1.	**2.**	**3.**	**4.**	**5.**	**6.**	**7.**	**8.**	**9.**	**10.**
1. log(total population)	1									
2. % White	–0.11	1								
3. % Urban	0.39	–0.12	1							
4. % Under 18	–0.12	–0.26	–0.16	1						
5. % Over 65	–0.14	0.17	–0.3	–0.46	1					
6. % with Bachelors or higher	0.29	0.04	0.5	–0.4	–0.28	1				
7. % In labor force (age 16 and over)	0.23	0.16	0.47	–0.29	–0.38	0.61	1			
8. % Income below poverty level	–0.14	–0.53	–0.32	0.31	0.17	–0.41	–0.67	1		
9. Change in median household income 1979–1989 (thousands of 1989$)	0.19	–0.08	0.03	–0.19	–0.05	0.32	0.29	–0.09	1	
10. Opioid dispensing rate in 2010 (prescriptions per 100 persons)	–0.06	0.02	0.15	–0.05	–0.04	–0.12	–0.12	0.09	–0.17	1

Table B: Descriptive Statistics, Appalachian vs. non-Appalachian counties

Variable	**Mean**		**Std. Dev**		**Min**		**Max**	
	Appalachia	Non-Appalachia	Appalachia	Non-Appalachia	Appalachia	Non-Appalachia	Appalachia	Non-Appalachia
Total population	52,000	87,000	94,000	270,000	4,400	1,700	1,500,000	7,500,000
% White	94	88	10	15	15	22	100	100
% Urban	26	43	23	29	0	0	96	100
% Under 18	29	29	2.7	3.6	20	16	38	47
% Over 65	12	13	2.2	4.1	5.1	1.4	21	34
% with Bachelors or higher	5.5	7.6	2.4	3.6	1.9	2	22	34
% In labor force (age 16 and over)	41	44	5.1	4.8	25	25	52	72
% Income below poverty level	17	14	7.1	6.7	5.6	3	48	50
Change in median household income 1979–1989 (thousands of 1989$)	–0.21	0.54	2.9	3.1	–9.9	–12	9.8	15
Opioid dispensing rate in 2010 (prescriptions per 100 persons)	120	87	59	45	0.6	1	390	570